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The Underwater Song of *Erignathus* (Bearded Seal)

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(Plates I-III; Text-figure 1; Phonograph Disk)

Vocalization by mature males during breeding season. The call consists of a long oscillating frequency-modulated warble that may be more than a minute in duration, followed by a short unmodulated low-frequency moan. It typically starts at about 2000 cps with many frequency variations and ends as low as 200 cps. This call has been identified with the species by our own observations and those of others. Examination of seals heard calling and which were killed revealed them to be males in breeding condition. Thus, this "song" is apparently used solely by mature males in spring courtship season. It is suggested that its purpose is a proclamation of territory or of breeding condition or both.

Introduction

Erignathus barbatus (Erxleben, 1777), the bearded seal, produces a long combination of complicated underwater sounds during the spring courtship season. This we have termed the "song" because of its complex musical quality and apparent behavioral significance. The characteristic frequency-modulated warble and low moan, though produced entirely underwater, may occasionally be heard in air, radiating through the water surface or ice-cover or through the hull of the boat.

These musical underwater sounds have been identified with the bearded seal by the Eskimos who habitually hunt the species as a major source of food and skins (Burns, 1967). The association of singing sounds with the seals is reflected in the names used for these animals by the Alaskan Eskimos; when the seals are singing, the term that is used ("aveloouk" – Upik dialect; "ayuktuk" – Inupik dialect) is translated as "the one that sings" or "the singer." The reference is to the bearded seal (in-air known as "mukluk" or "oogruk," respectively).

The song of *Erignathus* was described by Peter Freuchen (1921-24: pp. 224-225) as a "shrill, siren-like note which is made in the water and becomes deeper and deeper till it ends in a long-drawn-out sigh." The sigh he described as a "strange, dull, deep-toned sound," remarking that some "sighs" were accompanied by bubbles which he thought indicated that the seal would shortly surface. The description fits the underwater sound very well and has been quoted by other more recent authors. Poulter (1966) has described the underwater signals of *Erignathus*, but the spectrographic analyses he presents are hard to compare with ours since no scale is indicated and a non-standard logarithmic frequency portrayal is used. It seems likely that these are sounds of *Erignathus*, but we do not find either the high (6 kcps) frequency starts or the consistently distinct pulses he describes.

Over the past 10 years two of us (C. R. and J. B.) have observed *Erignathus* in the Bering Sea. These observations have included a number of instances when the "singing" could definitely be attributed to a seal in the water. Usually only a part of the song was heard in-air as a seal was closely approached, but through a series

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of such exposures a general impression of the song has been obtained. These impressions have been confirmed by underwater recordings made from shore, from pack ice, and from small boats on 7, 8, 9, 10, 14, 20, and 21 May 1966 near Gambell, St. Lawrence Island, Alaska (C. R.) and analyzed at Woods Hole Oceanographic Institution (W. W.). The dates of recording corresponded to the height of the courtship season. No other mammals were seen in the immediate vicinity during most of the listening periods, except for a few walrus, *Odobenus,* whose underwater sounds were noted to be similar to some of those reported from a captive (Schevill, Watkins, and Ray 1966).

The recordings were made with an LC-50 (Atlantic Research) hydrophone, a preamplifier (Watkins, 1963), and a Nagra III tape recorder. Analysis playback was by means of a Crown (800 series) recorder. The system was essentially flat from 50 to 10,000 cps. Spectrographic analyses were made on a Kay Electric Vibralyzer.

Acoustical Results

The song of *Erignathus* is both complicated and highly variable, yet by listening for an extended period an overall pattern for the song may be noted. The entire pattern occasionally is heard in one song; more often the song is fragmented with only parts of the song given and the variations predominating. At times a short rising trill may signal the repetition of a large part of the song, usually with additional variations. Our listening sample appears to have been large enough and from a sufficiently varied locale so as to offset limiting oceanographic factors, such as selective frequency attenuation and temperature/pressure effects. The fact that the song may be heard through the water-air interface indicates a relatively intense sound.

The song of *Erignathus* is a highly frequency-modulated call, much more so than that of any other marine animal we have herad. It may be continuous for more than a minute and is composed of short oscillations of the carrier-frequency (frequency-modulation) superimposed on longer-duration variations of the carrier-frequency. The song gives the aural impression of a long, siren-like oscillating warble. The song starts at 2000 to 3000 cps and ends at 200 to 300 cps; there is an overall downward sweep in frequency throughout the song, though there may be several short-term upward excursions. The song appears to end with a separate unmodulated low-frequency moan of two to three seconds duration and usually slightly decreasing frequency.

In our recordings, singing seals were numerous and never sufficiently isolated from their fellows to be certain of the attribution of the entire song to one individual. However, the pattern appeared generally to be the same. The variability noted in the detail of the pattern may be the result of individual preference.

Our representative song (Text-fig. 1) was as follows:

1) An introductory short warble which rose in frequency from 2500 to 3000 cps and lasted 2.5 seconds.

2) A second phrase 20 seconds in duration in which the carrier-frequency dropped from 3000 to 1000 cps.

3) A third phrase which lasted 3.5 seconds and rose to 2000 cps in carrier-frequency.

4) A repetition of phrase two with additional variations, 40 seconds in duration, which dropped to just below 1000 cps and was followed by a pause of 15 seconds.

5) An unmodulated moan which lasted 3 seconds and fell in frequency from 400 to 300 cps.

Detailed description of the song as heard from many individuals is as follows. The beginning phrase of the song (Pl. I) is a rising warble characterized by short bursts (100 to 250 msec. long) of frequency-modulation with oscillations of up to 1000-cps variation, separated by periods (100-150 msec.) of either less variation in frequency or unmodulated tone. This first phrase of the song may last 2.5 to 8 seconds.

The introductory phrase is followed by a long second phrase (Pl. II), an oscillating warble that may last a minute or more and that is composed of regular frequency oscillations produced at a relatively rapid rate (12-30 per second) superimposed on slower oscillations of the carrier frequency which vary at the rate of 3 per second to 1 per several seconds. The overall frequency drops during this phrase of the song and both the rapid frequency-modulation and the slower oscillation of the carrier-frequency occur progressively more slowly. Thus during the later portions of the second phrase, the song becomes more like a simple frequency-modulated warble in which the long carrier-frequency oscillations are of 5 to 10 seconds in duration. The sound may vary during frequency modulation by as much as 1000 cps, but the largest is usually about 500 cps.

A third phrase consisting of a short warble sometimes interrupts the second phrase, usually to be followed by a repetition of phrase two as another "verse" of varying length. This ascend-

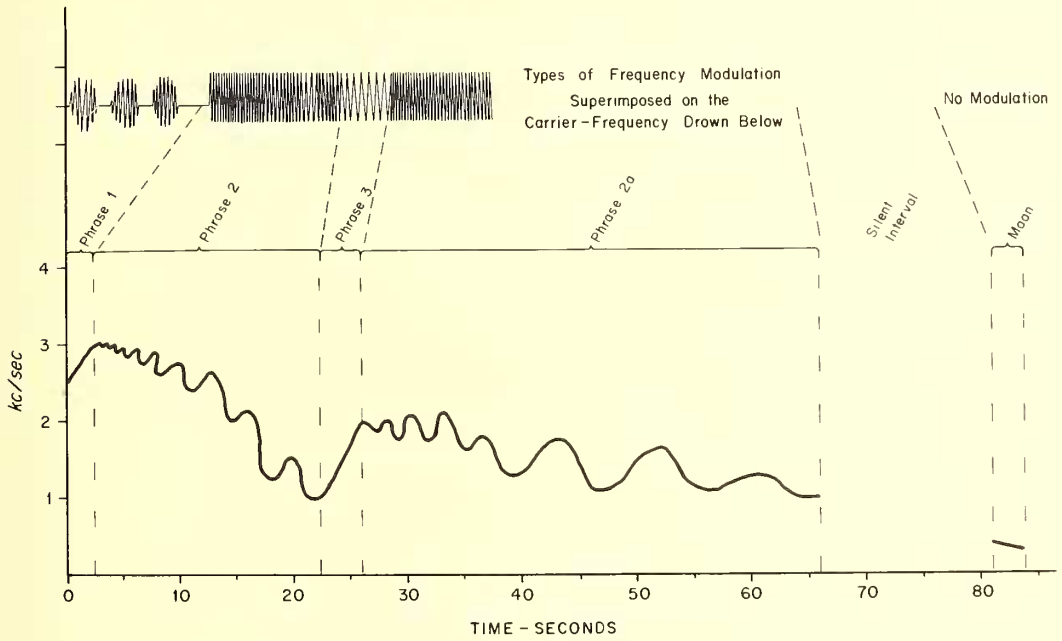
ing warble is relatively short (3 to 7 seconds) and has regular frequency-modulation as well as a steadily rising carrier-frequency (Pl. III). A typical insertion of the ascending trill into the song raises the carrier-frequency from about 1000 to 2000 cps allowing a repetition or a variation of the last portions of the song. The ascending warble is never used following a moan and is always inserted when the carrier-frequency of the song has dropped to 1000 cps or below.

The moan (lower portion, Pl. II) appears at the end of many of the *Erignathus* songs and so we include it as a part of the total song. Actually, there usually is a silence of up to 30 seconds (the interval is difficult to determine) between the last part of the slowly oscillating warble and the beginning of the moan. The moan is always lower in frequency than the earlier parts of the song. It is an unmodulated tone usually of descending frequency between 500 to 200 cps and of 2 to 3 seconds duration, contrasting sharply with the long frequency-modulated warble that precedes it. At close range, it is the moan that is associated with the appearance of bubbles and the subsequent surfacing of the seal.

Behavioral Observations

In spite of its superficial variability, the general pattern of the song of *Erignathus* is stereotyped and repetitive. It is complex and musical; it is seasonally produced and apparently sexually distinctive. It may also be territorial in function. In these respects the song of *Erignathus* fits the traditional usage of the term "song" as it is applied to the complex sound combinations of passerine birds.

In an effort to determine the role of the song a number of seals were collected (J. B.) It is the habit of *Erignathus* to swim in leads or openings in loose pack ice and individuals are not gregarious. Of 17 identified as singing and collected, all were males; of another 19 collected in the immediate vicinity of singing, 15 were males. All of these males proved to be sexually mature. Contrastingly, in July, though many seals of both sexes have been observed, none has been heard to sing. This strongly implies that the male *Erignathus* is proclaiming either its breeding territory in the pack ice or simply its availability or perhaps both. This is not in agreement with Freuchen's (1921-24) often quoted assertion that the song is used for communica-



Text-fig. 1. The lower portion of the drawing is a spectrographic portrayal of the characteristic (irregular sine-wave-like) variations in the carrier-frequency of an *Erignathus* song. Additional modulation is superimposed on these carrier-frequency variations and consists of relatively rapid frequency-modulation whose swing about the carrier-frequency may be as large as 1000 cps; this is portrayed in the upper portion of the drawing. During phrase one the frequency-modulation typically is in short bursts; phrase two has continuous but varying frequency modulation; phrase three has slower and more regular modulation; and the moan at the end is separated from the rest of the song by a silent interval and is unmodulated.

tion between mother and pup, nor with Poulter's (1966) evident belief that the song has a sonar function.

Our suggestions are reinforced by the observations of the Eskimos. Those that were interviewed agreed that the song is heard only from March through June and is associated with relatively short dives of about three minutes duration. They emphasized that bubbles always appear at the surface shortly after the moan is heard and that these bubbles are used as a convenient marker for the seal's appearance where it may be killed by the hunter.

The observation that in-air sound is used by phocid seals in territorial or courtship activities on land has been made for *Mirounga*, the elephant seal, by Bartholomew (1952). That sound is important in underwater courtship in its world of shore ice has also been suggested for *Leptonychotes*, the Weddell seal, by Ray (1967). Territory in the case of *Erignathus* would imply a lead or opening in the pack ice.

Summary and Conclusions

The underwater song of *Erignathus* usually consists of a long oscillating frequency-modulated warble that may be more than a minute in duration, followed by a short unmodulated low-frequency moan. The song typically starts at about 2000 cps with many frequency variations and ends as low as 200 cps. The song apparently is used only by mature males during the spring courtship season. It is suggested that its purpose is a proclamation of territory or of breeding condition or both.

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Literature Cited

Bartholomew, G. A., Jr.

1952. Reproductive and social behavior of the northern elephant seal. Univ. Calif. Publ. Zool., 47:369-472.

Burns, J. J.

1967. The Pacific bearded seal. Alas. Dept. of Fish and Game. Juneau. 66pp.

Freuchen, P.

1921-4. Mammals. Part II, Rept. Fifth Thule Exped., 2(4 & 5):68-278.

Poulter, T. C.

1966. Systems of echolocation. *In* Les Systèmes Sonars Animaux, *Ed* R.-G. Busnel. Lab. Physiol. Acous., Jouy-en-Josas, France, 1:157-185.

Ray, Carleton

1967. Social behavior and acoustics of the Weddell seal. Antarctic Jour., 2(4):105-106.

Schevill, W. E., W. A. Watkins, and Carleton Ray

1966. Analyses of underwater *Odobenus* calls with remarks on the development and function of the Pharyngeal pouches. Zoologica, 51(3):103-105.

Watkins, W. A.

1963. Portable underwater recording system. Undersea Tech., 4(9):23-24.

EXPLANATION OF THE PLATES

PLATE I

The song of *Erignathus* begins with an introductory warble (phrase one) that alternates short bursts of frequency-modulation separated by periods of relatively unmodulated tone. The sounds below 2 kcps are from more distant seals. The analyzing filter bandwidth is 200 cps.

PLATE II

A later portion during the *Erignathus* song (phrase two) is portrayed in the upper part of the spectrogram and shows rapid frequency-modulation superimposed upon carrier-frequency oscillations of longer duration. The lower part illustrates a moan at the end of another seal's song. The effective filter bandwidth in this analysis is 120 cps.

PLATE III

Sometimes interrupting phrase two is a short rising warble (phrase three) in which short-term modulations are regular and there are no longer oscillations as in phrase two. The analyzing filter bandwidth is 400 cps.

INSERTED

Phonograph disk of the underwater song of *Erignathus* (Bearded Seal).